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10/028,891	12/22/2001	Michael Coury	M-12421 US	2233

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EXAMINER	
PHAM, CHRYSTINE	
ART UNIT	PAPER NUMBER
2122	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	**Application No.** 10/028,891	**Applicant(s)** COURY ET AL.
	Examiner Chrystine Pham	**Art Unit** 2122

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 22 December 2001.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-30 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-30 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 22 December 2001 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claim 22 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 22 recites limitation "specifying a noise level ..." on lines 2-3. The specification does not contain a description of the invention, specifically, the process of specifying a noise level in the system in such full, clear, and exact terms as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claim 18 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 18 recites the limitation "the pulses" in lines 3, 4, and 5. There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

6. Claims 1-2, 4-14, 19-21, 24-29 are rejected under 35 U.S.C. 102(e) as being anticipated by Tucci (US 6456994), hereinafter, *Tucci*.

As per claim 1, *Tucci* teaches a quantum computing integrated development environment (QC-IDE) (e.g., see *classical computer 70, quantum computer 75* FIG.7 & associated text) comprising:

- a classical computer or computing hardware (e.g., see *classical computer 70* FIG.7 & associated text); and
- a computer program executed by the computer (e.g., col.3:3-7), wherein the computer program includes computer instructions (i.e.., method) (e.g., see *Qubiter* 54-65) for designing quantum logic with N qubits (e.g., see *QB Nets* col.1:19-21, col.4:15-50, see *N nodes, finite set of possible states of X.sub.j* col.4:44-49); and compiling the quantum logic into a set of quantum machine language instructions (i.e., preparing a sequence of fundamental operators or operations) (e.g., see *SEO, sequences of elementary instructions* col.1:25-36, see FIG.9 & associated text, col.1:45-53, col.3:3-7); wherein the quantum machine language instructions are executable by a quantum computing system (e.g., see *quantum computer 75* FIG.7 & associated text, col.1:63-65).

As per claim 2, *Tucci* teaches the QC-IDE as applied to claim 1, wherein a set of quantum machine language instructions includes a set of hardware executable instructions (e.g., see *quantum computer 75* FIG.7 & associated text), wherein at least one instruction in said instruction set can only be executed on quantum computing hardware (e.g., see *quantum computation, SEO, qubits* col.1:34-36, col.2:65-67, see *roty, rotz* FIG.9,10 & associated text).

As per claim 4, it recites limitations which have been addressed in claim 1, therefore, is rejected for the same reasons as cited in claim 1.

As per claim 5, *Tucci* teaches the QC-IDE as applied to claim 4, wherein the sequence of fundamental operators includes all possible unitary transformations (i.e., unitary simplifications or commutations) for a particular quantum computing system (e.g., see *unitary operators* col.1:53-57, see *possible states of X.sub.j* col.4:42-49, see *all the possible X.sub.j components* col.4:55-59, see FIG.8,9 & associated text, see *decomposition* col.4:1-4, col.5:5-11, see FIG.1 & associated text, see *N.sub.s=2^N.sub.b*, *N.sub.b bits* col.9:63-64).

As per claim 6, *Tucci* teaches the QC-IDE as applied to claim 5, wherein a quantum computing system is any quantum system that provides a universal set of unitary operators (e.g., see *sequence of unitary operators* col.1:54-57).

As per claim 7, *Tucci* teaches the QC-IDE as applied to claim 5, wherein a fundamental operator has a unitary, 2.sup.N by 2.sup.N matrix (e.g., see *unitary matrix U.sub.a* col.8:35-40, see *a=1* col.9:19, see *N.sub.s X N.sub.s matrix U.sub.1* col.9:23-24, see *N.sub.s=2^N.sub.b* col.9:63-64, see *61* FIG.6 & associated text).

As per claim 8, *Tucci* teaches the QC-IDE as applied to claim 7, wherein a single qubit fundamental operator is represented by a unitary matrix σˆ x = [0 1 1 0] (e.g., see *σ.sub.x=[0 1 1 0]* col.10:30-35)

As per claim 9, *Tucci* teaches the QC-IDE as applied to claim 7, wherein a single qubit fundamental operator is represented by a unitary matrix σˆz = [1 0 0 - 1] (e.g., see *σ.sub.z=[1 0 0 −1]* col.10:30-35).

As per claim 10, *Tucci* teaches the QC-IDE as applied to claim 7, wherein a single qubit fundamental operator is represented by a unitary matrix σˆy = [0 - i i 0] (e.g., see *σ.sub.y=[0 - i i 0]* col.10:30-35)

As per claim 11, *Tucci* teaches the QC-IDE of claim 4, wherein a sequence of fundamental operators applies to a single qubit or plurality of qubits (e.g., see *few bits (usually 1, 2, or 3) at a time* col.1:25-31, col.1:34-36).

As per claim 12, it recites limitations which have been addressed in claim 11, therefore, is rejected for the same reasons as cited in claim 11.

As per claim 13, *Tucci* teaches the QC-IDE as applied to claim 1 wherein the computer program includes computer instructions for defining a sequence of fundamental operators as a single abstract operator (e.g., see *each of those unitary operators* col.1:54-57).

As per claim 14, *Tucci* teaches the QC-IDE as applied to claim 1, wherein the computer program includes computer instructions for preparing a sequence of abstract operators (e.g., see *sequence of unitary operators* col.1:54-57).

As per claim 19, *Tucci* teaches the QC-IDE as applied to claim 1, wherein the computer program includes computer instructions for selecting a quantum computing system (e.g., see *QB Nets* col.1:19-22, col.1:49-53, see *arbitray QB net* col.1:62-65).

As per claim 20, *Tucci* teaches the QC-IDE as applied to claim 1, wherein designing quantum logic includes defining a quantum computing system (e.g., see *QB Nets* col.1:19-21, col.4:15-50, see *N nodes*, *finite set of possible states of X.sub.j* col.4:44-49).

As per claim 21, *Tucci* teaches the QC-IDE as applied to claim 20, wherein defining a quantum computing system includes specifying a set of fundamental operations (see *fundamental operators* in claim 1).

As per claim 24, it recites limitations which have been addressed in claims 1, 13-14, therefore, is rejected for the same reasons as cited in claims 1, 13-14.

As per claim 25, *Tucci* teaches the QC-IDE as applied to claim 1, wherein the computer program includes computer instructions for converting said quantum logic between a sequence of abstract operators (see claim 14) and a sequence of fundamental operators (e.g., see *each of those unitary operators, SEO* col.1:54-57).

As per claim 26, *Tucci* teaches the QC-IDE as applied to claim 1, wherein converting between a sequence of abstract operators and a sequence of fundamental operators (e.g., see claim 25) includes use of a set of simplification rules (e.g., see *reduce* col.1:54-57).

As per claim 27, it recites limitations which have been addressed in claims 26 and 5, therefore, is rejected for the same reasons as cited in claims 26 and 5.

As per claim 28, *Tucci* teaches the QC-IDE as applied to claim 26, wherein a simplification rule is redundancy between fundamental operators (e.g., see *rotz 0 0.00000000, rotz 1 0.00000000* FIG.9 & associated text, see FIG.10 & associated text, see *NAND, quantum computation* col.17:23-30).

As per claim 29, *Tucci* teaches the QC-IDE as applied to claim 25, wherein the computer instructions for converting quantum logic between a sequence of abstract operators and a

sequence of fundamental operators includes computer instructions for representing each abstract operator in said sequence as an equivalent sequence of fundamental operators (e.g., see *equivalent transformations of the array* col.18:25-29).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over unpatentable over *Tucci* as applied to claim 2 above further in view of Ulyanov (US 6578018), hereinafter, *Ulyanov*.

As per claim 3, *Tucci* teaches the QC-IDE as applied to claim 2. *Tucci* does not expressly disclose said set of quantum machine language instructions further includes instructions executable on classical computing hardware. However, *Ulyanov* discloses a method of generating quantum machine language instructions, which can be run (executable) on a classical computing hardware (e.g., see *quantum logic or algorithm* col.2:29-35). *Tucci* and *Ulyanov* are analogous art because they are both directed and generating quantum logic for executing on a quantum computer. It would have been obvious to one of ordinary skill in the pertinent art at the time the invention was made to combine the teaching of *Ulyanov* with that of *Tucci* to include the generation of quantum machine language instructions which are executable on classical computing hardware. And the motivation for doing so would have been to enable the quantum computer to be simulated by the classical computing hardware, thus, concepts, features, and principles of quantum computing (e.g., superposition, entanglement, quantum interference, massive parallelism) could be utilized to advantage by classical computing hardware without the need to develop quantum computer hardware.

9. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over unpatentable over *Tucci* as applied to claim 20 above further in view of Kimble et al. (US 5339182), hereinafter, *Kimble et al.*.

As per claim 22, *Tucci* teaches the QC-IDE as applied to claim 20. *Tucci* does not expressly disclose specifying a noise level in the system. However, *Kimble et al.* disclose a quantum communication system (e.g., see FIG.1 & associated text) and method of specifying a quantum noise level in the system (e.g., col.1:47-49, see *correlated quantum noise* col.2:30-34, col.2:45-46). It would have been obvious to one of ordinary skill in the pertinent art at the time the invention was made to modify the teaching of *Tucci* with that of *Kimble et al.* to include specifying a quantum noise level in the system. And the motivation for doing so would have been to obscure and protect encoded data using the specified correlated noise level during data transmission against eavesdropping or unauthorized extraction of the encoded information without requiring the use of an encryption algorithm.

10. Claims 15-17, 23 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over unpatentable over *Tucci* in view of Gershenfeld et al. (US 5917322), hereinafter, *Gershenfeld et al.*

As per claim 15, *Tucci* teaches the QC-IDE as applied to claim 1. *Tucci* does not expressly disclose computer instructions for setting the driver specifications. However, *Gershenfeld et al.* disclose a quantum computing environment (e.g., see FIG.1 & associated text) comprising computer instructions for setting the driver specification (i.e., setting frequency for each of the fundamental operators, setting time unit or duration of pulses, and setting amplitude of pulses) (e.g., see *duration t.sub.p* col.5:59-64, see *appropriate choice of the frequency & arbitrary rotation* col.6:29-36, see *arbitrary single-spin rotation* & *unitary operators* col.14:33-44,

see *given amplitude and frequency and time-varying* col.17:10-14). *Tucci* and *Gershenfeld et al.* are analogous art because they are both directed at generating quantum logic. It would have been obvious to one of ordinary skill in the pertinent art at the time the invention was made to modify the teaching of *Tucci* with that of *Gershenfeld et al.* to include computer instructions for setting driver specification (i.e., setting frequency of fundamental operators, setting time unit or duration of pulses, and setting amplitude of pulses). And the motivation for doing so would have been that setting (or modulating) the time unit (i.e., duration), and amplitude of pulses enables information to be encoded in the pulses by reflecting the information with the modulated pulse properties (i.e., duration, amplitude). In quantum computing, setting the duration of pulses enables the modification of a set of qubits so as to remove it from thermal equilibrium, redistribution of quantum states and creation of coherences between them, and setting the frequency associated with the pulses enables them to be utilized in reversing the evolution of Hamiltonian interaction terms. The manipulation of pulse properties in quantum computing enables the generation of arbitrary single-spin rotation, which in turns, facilitates the execution of single-bit operation (i.e., unitary operator). In other words, pulse manipulation facilitates the encoding or manipulation of a desired operation of sequence of operations defining computations of interest.

As per claims 16-17, and 23, they recite limitations which have been addressed in claim 15, therefore, are rejected for the same reasons as cited in claim 15.

As per claim 30, *Tucci* teaches a method for quantum computing, the method comprising: designing quantum logic with N qubits (see claim 1); compiling the quantum logic into a set of quantum machine language instructions (see claim 1); executing the quantum machine language instructions on a quantum computing system (see claim 1); *Tucci* does not expressly disclose outputting results of the execution of the quantum machine language instructions. However, *Gershenfeld et al.* disclose a quantum computer outputting results of the execution of the

quantum machine language instructions (e.g., see *READOUT SYSTEM 70* FIG.1 & associated text, see *reading out the results* col.3:48-53, col.16:9-12). It would have been obvious to one of ordinary skill in the pertinent art at the time the invention was made to incorporate the teaching of *Gershenfeld et al.* into that of *Tucci* to include outputting the results of the execution of the quantum machine language instructions. And the motivation for doing so would have been to enable further analysis of the outputted results (e.g., quantum states) which can be used in the process of scaling up the computation space so that multiple operations can be carried out in parallel.

11. Claims 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over unpatentable over *Tucci* in view of Gershenfeld et al. (US 5917322), hereinafter, *Gershenfeld et al.* further in view of Bonato et al. (US 6583905), hereinafter, *Bonato et al.*.

As per claim 18, *Tucci* as modified by *Gershenfeld et al.* (hereinafter ***T2***) teach the QC-IDE as applied to claim 16 wherein setting the frequency of a fundamental operator includes setting the time unit of the pulses and the amplitude of the pulses (see claim 15). ***T2*** do not expressly disclose setting the sharpness of the pulses. However, *Bonato et al.* disclose a system and method for setting the sharpness of the pulses (e.g., see *sharp-edged pulses* Abstract, see *transponder* col.4:60-64, col.4:30-41, see *transponder* col.4:60-64, see FIGS.2A,2B,2C,2D,2E & associated text). ***T2*** and *Bonato et al.* are analogous art because they are both directed toward data processing using pulse manipulation. It would have been obvious to one of ordinary skill in the pertinent art at the time the invention was made incorporate the teaching of *Bonato et al.* into that of ***T2*** to include setting sharpness for the pulses. And the motivation for doing so would have been minimize the effect of phase jitter and improve detection (i.e., reduce non-linear distortion) in an optical transmission system.

Conclusion

12. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

- Fast quantum mechanical algorithms, Grover (US 6317766)
- Method and apparatus for transmitting and receiving signals having a carrier interferometry architecture, Shattil (US 6686879)
- Optical method for quantum computing, Franson (US 6678450)
- Optical pulse generation system for generating optical pulses having high duty ratio, Otani et al. (US 6483624)
- Pulse transmission transceiver architecture for low power communications, Dress, Jr. et al. (US 6603818)
- Apparatus and method for equalization in distributed digital data transmission systems, Rakib et al. (US 6665308)
- Graphical computer method for analyzing quantum systems, Tucci (US 5787236)

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Chrystine Pham whose telephone number is 703.605.1219. The examiner can normally be reached on Mon-Fri, 8:30am-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tuan Q Dam can be reached on 703.305.4552. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Chrystine Pham
Examiner

Chali C. Das
CHAMELI C. DAS
PRIMARY EXAMINER
10/14/04

GAU 2122

*** After October 25, 2004, examiner can be reached at new telephone number (571) 272-3702, and the examiner's supervisor, Tuan Q. Dam can be reached on (571) 272-3694.

CHAMELI C. DAS
PRIMARY EXAMINER